U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Strymon acis bartrami*

COMMON NAME: Bartram's hairstreak butterfly

LEAD REGION: 4

INFORMATION CURRENT AS OF: August 4,2006

STATUS/ACTION

___ Species assessment - determined we do not have sufficient information on file to support a proposal to list the species and, therefore, it was not elevated to Candidate status
_X_ New candidate
___ Continuing candidate
___ Non-petitioned
___ Petitioned - Date petition received:
__ 90-day positive - FR date:
__ 12-month warranted but precluded - FR date:
__ Did the petition request a reclassification of a listed species?

FOR PETITIONED CANDIDATE SPECIES:
a. Is listing warranted (if yes, see summary of threats below)?
b. To date, has publication of a proposal to list been precluded by other higher priority listing actions?
c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded.

___ Listing priority change
Former LP: ___
New LP: ___
Date when the species first became a Candidate (as currently defined):
___ Candidate removal: Former LPN: ___
___ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
___U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.
___ F – Range is no longer a U.S. territory.
___ I – Insufficient information exists on biological vulnerability and threats to support listing.
___ M – Taxon mistakenly included in past notice of review.
___ N – Taxon does not meet the Act's definition of "species."

___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Insects, Lycaenidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Florida, U.S.A.

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Florida, Monroe and Miami-Dade Counties, U.S.A.

LAND OWNERSHIP: There are only two small, isolated populations of Bartram's hairstreak remaining. The larger occurs on the mainland within Long Pine Key in Everglades National Park (ENP); the smaller occurs on Big Pine Key. On Big Pine Key, the butterfly and appropriate habitat occur within the National Key Deer Refuge (NKDR) and on private, State, and other lands (Salvato 1999; M. Salvato, Service, pers. comm. 2006). On the mainland, sporadic and localized populations of Bartram's hairstreak have been found within pine rockland fragments on lands owned by Miami-Dade County. Relict pine rocklands on other private lands may also provide suitable or potential habitat for Bartram's hairstreak.

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BIOLOGICAL INFORMATION

Species Description: The Bartram's hairstreak is a small butterfly approximately 1 inch (in) (25 millimeters (mm)) in length with a forewing length of 0.4 to 0.5 in (10 to 12.5 mm) and has an appearance characteristic of the genus (Comstock and Huntington 1943, Pyle 1981, Opler and Krizek 1984, Minno and Emmel 1993). Despite its rapid flight, this hairstreak is easily observed if present at any density as it alights often, and the brilliance of its grey underside marked with bold white postdiscal lines beneath both wings provides an instant flash of color against the foliage of its hostplant, pineland croton (*Croton linearis*) (Euphorbiaceae) (Smith et al. 1994, Salvato 1999). The Bartram's hairstreak does not exhibit sexual or seasonal dimorphism.

Eggs are laid singly on the flowering racemes of the hostplant, pineland croton (*Croton linearis*) (Euphorbiaceae) (Salvato 1999). First and second instars remain well camouflaged amongst the white croton flowers, while the later stages roam the entire plant. Salvato and Hennessey (2004) reported approximate body lengths 2, 4, 6 and 11 mm for Bartram's hairstreak 2nd through 5th instar larvae, respectively.

Taxonomy: The Bartram's hairstreak butterfly, *Strymon acis bartrami*, was first described by Comstock and Huntington in 1943 (Comstock and Huntington 1943). The Bartram's hairstreak is one of seven subspecies of *Strymon acis* (Smith et al. 1994). Smith et al. (1994) indicate that perhaps no other butterfly in the West Indies has evolved as many distinct island subspecies as *S. acis.* Each group of Antillean islands appears to have its own particular set of *S. acis* hairstreaks,

and these have been classified into two separate groups. The Type A subspecies are larger, darker colored and are found in the more southeastern Antillean islands. The Type B subspecies, to which the Bartram's hairstreak belongs, are smaller, more surface-grey colored. The Bartram's hairstreak is endemic to Florida and occurs nowhere else in the world.

We have carefully reviewed the available taxonomic information on the Bartram's hairstreak (Comstock and Huntington 1943, Smith et al. 1994, Worth et al. 1996, Salvato and Hennessey 2004) and have reached the conclusion that the species is a valid taxon and an entity that could be listed pursuant to the Endangered Species Act (ESA).

Habitat/Life History: The Bartram's hairstreak occurs only within pine rocklands that retain its hostplant, pineland croton. Pineland croton, a subtropical species of Antillean origin, is the only known host plant for Bartram's hairstreak (Opler and Krizek 1984, Schwartz 1987, Minno and Emmel 1993, Smith et al. 1994). Therefore, Bartram's hairstreak is restricted to pine rocklands that contain pineland croton.

Once occurring throughout the pine rocklands of the lower Florida Keys (Dickson 1955, Folk 1991, Hennessey and Habeck 1991, Salvato 1999), pineland croton now occurs only on Big Pine Key. The last reports of the hostplant from other keys were from No Name in 1992 (Carlson et al. 1993) and from Little Pine (Folk 1991). Recent surveys of relict pineland throughout the lower keys for pineland croton by Salvato (1999, pers. comm. 2006) have failed to locate the plant from any island other than Big Pine. Hennessey and Habeck (1991) and Salvato (1999) estimated that approximately 80 ha (198 acres) of appropriate hostplant-bearing pine rockland habitat occur within NKDR. Another 1,068 ha (2,639 acres) of pine rockland habitat with appropriate hostplant occur within ENP (Hennessey and Habeck 1991, Salvato 1999). Fire is an essential element in maintaining pine rocklands.

The Bartram's hairstreak has a rapid flight pattern and often alights on low lying vegetation (Salvato 1999). Bartram's hairstreak has been observed during every month on Big Pine Key and ENP; however the exact number of broods appears to be sporadic from year to year (Salvato and Hennessey 2004). Baggett (1982) indicated that the Bartram's hairstreak seemed most abundant in October-December. Salvato (1999) recorded 92 adult Bartram's hairstreak from across Big Pine Key during a one-week period in July 1997, suggesting the species can occur in high numbers throughout the year if suitable habitat and conditions are present (M. Salvato, pers. comm. 2006).

Females oviposit on the flowering racemes of the hostplant, pineland croton (Salvato and Hennessey 2004). Eggs are laid singly on the developing hostplant raceme. Hennessey and Habeck (1991) observed a female oviposit three eggs over the course of five minutes. This long duration likely enables females to serve as one of the major pollinating species for the hostplant (Salvato 1999, in press). First and second instars remain well camouflaged amongst the white croton flowers, while the later stages roam the entire plant. Unlike with other sub-tropical lycaenid butterflies, there have been no observed instances of obligatory relations of Bartram's hairstreak larvae and ants during studies (Worth et al. 1996, Salvato and Hennessey 2004).

The Bartram's hairstreak is most often observed visiting flowers of the host for nectar, but has also been observed using the flowers of several other species, including: pine acacia (*Acacia pinetorum*), Spanish needles (*Bidens alba*), saw palmetto (*Serenoa repens*), and buttonsage (*Lantana involucrate*) (Minno and Emmel 1993, Worth et al. 1996, Calhoun et al. 2002, Salvato and Hennessey 2004).

Historical Range/Distribution: The Bartram's hairstreak is endemic to south Florida and the lower Florida Keys, occurring nowhere else in the world. The other subspecies of *Strymon acis* occur throughout the West Indies (Smith et al. 1994).

The Bartram's hairstreak was once common within the widespread pine rockland habitat that occurred within Miami-Dade and Monroe Counties, less common and sporadic within Collier, Palm Beach, and Broward Counties (Baggett 1982, Smith et al. 1994, Salvato 1999, Salvato and Hennessey 2004). Historically, pine rockland habitat covered 65,450 ha (161,730 acres) within Miami-Dade County (Loope and Dunevitz 1981, Service 1999). However, development has removed and/or fragmented pine rocklands from the majority of the hairstreak's former range on peninsular Florida and the lower Florida Keys (Service 1999, Salvato 1999). The rapid loss of habitat and the resulting increased distance between substantial populations of hostplants in the remaining pine rocklands is the most likely cause for the species disappearance from the southern Florida mainland and lower Florida Keys.

Current Range/Distribution: Populations of Bartram's hairstreak have become increasingly localized as pine rockland habitat has been lost or altered through anthropogenic activity (Baggett 1982; Hennessey and Habeck 1991; Schwarz et al. 1996; Salvato 1999, 2001, in press; Salvato and Habeck 2004). The Long Pine Key portion of ENP contains the largest remaining coverage of pine rockland habitat (8,029 ha or 19,831 acres) on peninsular Florida (Salvato 1999, Service 1999, Salvato and Hennessey 2004). However, Hennessey and Habeck (1991) and Salvato (1999) estimated that approximately 1,068 ha (2,638 acres) of appropriate hostplant-bearing pine rockland habitat occur within Long Pine Key (all within ENP) for use by the Bartram's hairstreak.

In Miami-Dade County, outside of ENP, there are approximately 375 pine rockland fragments remaining totaling approximately 1,780 ha (4,398 acres) (DERM 1995). Several of these fragments, particularly ones that are adjacent to ENP, such as Navy Wells Pineland Preserve and Camp Owaissa Bauer Hammock, appear to maintain small, localized populations of pineland croton as well as sporadic populations of Bartram's hairstreak (Salvato 1999, in press; Salvato and Hennessey 2004; M. Salvato, pers. comm. 2006). A GIS analysis conducted by the Service using 2004 data indicates that 65 pine rockland fragments containing pineland croton remain in private ownership in Miami-Dade County; these total approximately 190 ha (470 acres) (The Institute for Regional Conservation (IRC) unpublished data). Another 12 fragments totaling 180 ha (446 acres) contain croton and are in public ownership (IRC unpublished data). The more recent analysis likely under-represents Bartram's hairstreak habitat because it only involved areas where access was allowed and only examined fragments containing croton.

In the lower Florida Keys, Big Pine Key retains the largest undisturbed tracts of pine rockland

habitat totaling an estimated 701 ha (1,732 acres) (Folk 1991, Hennessey and Habeck 1991, Salvato and Hennessey 2004). Although relict pine rocklands can still be found on several other islands within NKDR, only Big Pine Key maintains pineland croton (Salvato 1999, Salvato and Hennessey 2003, 2004). As a result, the Bartram's hairstreak is present only on Big Pine Key within the Florida Keys. Hennessey and Habeck (1991) and Salvato (1999) estimated that approximately 80 ha (198 acres) of appropriate hostplant-bearing pine rockland habitat occur within NKDR for use by the Bartram's hairstreak.

Population Estimates/Status: Based on the results of historic (Baggett 1982, Schwartz 1987, Hennessey and Habeck 1991, Worth et al. 1996, Schwarz et al. 1996) and recent (Salvato 1999, 2001, in press; Salvato and Hennessey 2004; M. Salvato, pers. comm. 2006) surveys and natural history studies for this species, there appears to be only two remaining populations of Bartram's hairstreak. Surveys of the Bartram's hairstreak by Hennessey and Habeck (1991) and Salvato (1999, 2001) indicated that this butterfly was either locally common or rare in many pine rockland locations on Big Pine Key and sporadic in Long Pine Key for the duration of their respective studies. Hennessey and Habeck (1991) reported an estimate of 3.9 and 1 adult Bartram's hairstreaks per ha (1.6 and 0.4 per acre) during 1988-89 from survey transects on Big Pine Key and Long Pine Key, respectively. During 1997-98, Salvato (1999) recorded an estimated 4.3 adult butterflies per ha (1.7 per acre) at survey transects across NKDR. However, Salvato (1999, 2001) failed to find stable numbers in either the Watson's Hammock portion of NKDR or in Long Pine Key. The lower densities of Bartram's hairstreaks in Watson's Hammock and Long Pine Key reported by Salvato (1999, 2001, pers. comm. 2006) and Salvato and Hennessey (2004) during the late 1980s and 1990s have been attributed to a lack of the adequate prescribed fires necessary in the pine rockland habitat to maintain appropriate levels of hostplants. As of mid 2006, Salvato (pers. comm. 2006) has recorded an average of 1.7 to 5 adults per ha (0.7 to 2.0 per acre) at transects across NKDR from 1997-2006.

Salvato (1999, in press) noted that the Bartram's hairstreak had either been extirpated or greatly reduced across the majority of Long Pine Key at the time of his 1997-98 studies. However, due in large part to an effective and systematic burn plan, Salvato (pers. comm. 2006) estimates the area now has maintained an average of 2 adults per ha (0.8 per acre) at Gate 4 from 1999-2005. Despite extensive monitoring, Salvato (pers. comm. 2006) only sporadically observes the species within pine rockland areas adjacent to ENP, such as Navy Wells. Salvato (pers. comm. 2006) estimated that the population collectively at Big Pine Key, Long Pine Key, and within relict pine rocklands adjacent to ENP may range from roughly 160 – 800 adults.

THREATS

A. The present or threatened destruction, modification, or curtailment of its habitat or range. The pine rockland community of southern Florida is globally endangered. Destruction of the pinelands for economic development has reduced this unique community by 90% on mainland south Florida (O'Brien 1996) and to 918 ha (2,268 acres) in the lower Florida Keys (Ross et al. 1994). The threat of habitat loss of remaining unprotected pine rocklands continues today. Pine rockland fragments outside of ENP in Miami-Dade County still contain pineland croton and provide occupied or suitable habitat for the Bartram's hairstreak.

In particular, sites such as Navy Wells Pineland Preserve and Camp Owaissa Bauer Hammock appear to maintain small, localized populations of pineland croton and sporadic populations of Bartram's hairstreak (Salvato 1999, in press; Salvato and Hennessey 2004). A recent GIS analysis for Miami-Dade County indicates that 65 pine rockland fragments containing pineland croton remain in private ownership, totaling approximately 190 ha (470 acres) (IRC unpublished data). In short, sporadic populations of Bartram's hairstreak occurring on unprotected lands remain threatened by habitat destruction or modification.

Similarly, while NKDR retains the largest undisturbed tracts of pine rockland habitat in the lower Florida Keys, other areas on Big Pine Key containing occupied and suitable habitat for the Bartram's hairstreak remain unprotected. Therefore, suitable habitat for Bartram's hairstreak outside of NKDR boundaries remains at risk. Residential and commercial development has degraded essential components of Bartram's hairstreak habitat, and continues to pose a threat to remaining habitat.

The threat of habitat destruction or modification is further exacerbated by lack of prescribed fire and suppression of natural fires. Natural fires are an important part of maintaining an ecosystem's gradual succession (Lay 1956, Olson and Platt 1995, Johnson and Miyanshi 1995, Bergh and Wisby 1996, Slocum et al. 2003). Natural fires are important in maintaining the herbaceous layer of pine rocklands of which pineland croton is a part (Loope and Dunevitz 1981, Carlson et al. 1993, Olson and Platt 1995, Bergh and Wisby 1996, Platt et al. 2000). In pine rockland habitat, frequent fires in the dry season burn back the overgrowth of the herbaceous layer, allowing native shrubs to re-sprout from secondary roots under the slash pine canopy. Re-sprouting after burns is the primary mechanism allowing for the persistence of perennial shrubs in pine habitat (Olson and Pratt 1995). Without these fires, climax from tropical pineland to hardwood hammock is rapid. However, due to the proximity of remaining pine rockland habitat to urban areas in southern Florida and the Keys much of these natural fires have been suppressed, often replaced by inconsistent regimes of managed or prescribed fires.

On the southern mainland this process of broad-leaved species overtaking pine rockland and limiting their reproduction takes about 30 years (Alexander and Dickson 1972, Carlson et al. 1993, Bergh and Wisby 1996). An endemic species can be shaded out of the Long Pine Key pine rocklands in less than 15 years. Loope and Dunevitz (1981) found that a pine rockland left unburned for 35 years had lost all of its endemic plants.

Prescribed fire is used throughout the pine rocklands of Long Pine Key and has been consistently used for the past 50 years (Loope and Dunevitz 1981, Salvato 1999). Historically, however, when prescribed burns were conducted in Long Pine Key, the majority of the pine rockland habitat was burned in its entirety. This pattern of burning likely forced populations of Bartram's hairstreak to the fringes of Long Pine Key, greatly fragmenting the species distribution. Moreover, because the Bartram's hairstreak is rarely encountered more than 5 m (16.4 feet) from the hostplant (Worth et al. 1996), is it believed that the historic large-scale burns of Long Pine Key most often eradicated hairstreaks at the burn site (Salvato 1999).

The National Park Service's (NPS) fire management goals for ENP are: ensure the health and safety of firefighters, employees, and the public; use fire in a manner that sustains a healthy and natural ecosystem; protect special values at risk; maintain safe and effective fire readiness; continue to strengthen cooperative fire management activities; enhance visitor experience; and maintain a framework of adaptive management (NPS 2005). Unlike previous fire management plans, the current draft plan incorporates the full range of wildland fire management strategies that may be used throughout the Park (NPS 2005). Management strategies include: wildland fire suppression, wildland fire use, prescribed fire, and non-fire applications.

There have been infrequent wildfires or wildland fire use fires in the pine rockland fire management unit (FMU 3) in the last 20 years (NPS 2005). Within this FMU, agricultural conversion (in the Hole-in-the-Donut) removed 6,250 acres of native vegetation that had the ability to carry fire into the adjacent pinelands on prevailing winds; this disturbance limited the potential for natural fires to occur in the pinelands (NPS 2005). In addition, paved roads, fire roads, and water management features have combined to compartmentalize both prescribed fire and natural fire (NPS 2005).

Since 1989, prescribed fires at Long Pine Key have been conducted every 2-3 years to mimic natural fire regimes historically ignited by lightening strikes (Robertson 1953, Slocum et al. 2003, Salvato and Hennessey 2004). Although this has resulted in restoration of species-rich, herbaceous-dominated pine rocklands in many areas, including resurgence of pineland croton, the populations of this plant remain fragmented. Fragmentation is a concern for the Bartram's hairstreak because this butterfly is relatively sedentary, generally not straying far from its host plant.

Since 2001, prescribed fire in FMU 3 has been planned on a landscape scale versus unit scale in part to reduce the effects of compartmentalization (NPS 2005). Current fire management practices at Long Pine Key in ENP use partial and systematic prescribed burns and are done in a way that burns nearly all of the pine rocklands over a three-year window. Consequently, Salvato (pers. comm. 2006) has found that Bartram's hairstreak has returned to Gate 4 and elsewhere in Long Pine Key. Fire management in Long Pine Key attempts to burn adjacent pine rockland habitats alternately. Although not specifically managed for any single species, the current practice allows both a corridor for the butterflies to traverse at the time of the burn and provides nearby refugia for them to remain within while the burned site regenerates. Bartram's hairstreaks are then provided an easier route back to the recently burned adjacent area which aides in faster re-colonization. Ideally, and historically, during this three-year interval, the butterflies will move from the burned location to adjacent refugia and then back to burned area in numbers equal to or greater than before the fire. The effects of this new burn technique were not immediately obvious when this plan took effect, but as of 2006, the hairstreak appears to have greatly benefited with population densities in the fall of 2004 and winter/spring 2005 greater than those recorded in any of the previous studies (M. Salvato, pers. comm. 2006).

The NPS acknowledges that endangered and threatened species and their habitats are the principle natural values at risk within FMU 3 (NPS 2005). ENP is working on incorporating considerations for life histories of select butterfly species into its management, but there may be some inconsistencies between implementation of the plan and meeting the needs for select species. For example, portions of Long Pine Key were burned in the early summer of 2005 and suffered substantial hurricane damage (in late summer 2005), which altered regeneration. If remaining areas are burned before previously altered habitat fully regenerates, it could have severe ramifications for Bartram's hairstreak at Long Pine Key; however, at this time we do not know whether ENP plans to burn prior to regeneration of previously altered habitat.

Historically, a 10-20 year burn interval maintained pine rocklands on many of the larger islands in NKDR, such as Big Pine, Sugarloaf, and Cudjoe Keys. While on the drier, more isolated parts of NKDR, such as No Name and Little Pine Keys, this succession takes twice as long. A 10-50 year interval on these smaller islands serves to arrest succession at an intermediate stage.

Fire suppression results in the invasion and replacement of native pine rockland habitat by hardwood hammocks. Native species that would normally be an integral part of the pine rockland ecosystem are at a disadvantage, because they can not adjust to the effects of rapid succession and climax. Furthermore, in many instances, native plant species are unable to survive competition from ever increasing invasive plant populations, many of which are far better adapted to make use of these altered ecosystems. The conversion of pine rockland into hardwood hammock continues on northeastern Big Pine, No Name, and Little Pine Keys, and the Bartram's hairstreak hostplant is now completely absent from these locations.

The objectives of the current NKDR fire management program are to: (1) protect human life, property, and other resources from unwanted fire; and (2) restore and maintain biological diversity using fire as a viable ecological process (Service 2000). The latter includes maintaining biological diversity in fire-maintained plant communities by prescribed fire and also controlled natural fire under Service guidelines and maintaining habitat for trust resources, including endangered and threatened plant and animal species, especially the Key deer, through prescribed fire and controlled natural fire (Service 2000). The fire management plan for NKDR mentions Bartram's hairstreak and its reliance on its fire-dependent host plant and indicates that "Concern has been raised that fire suppression is contributing to the decline of these species as the host plant requires a fire maintained open pineland to persist (Emmel et al. 1995)." However, no specific details are provided to enhance habitat or avoid / mitigate impacts to Bartram's hairstreak. In addition, management of pine rocklands by NKDR is made particularly difficult by the pattern of land ownership and development; private homes and light commercial uses are embedded within or in close proximity to the fire-sustained pineland habitat (Service 2000).

Salvato (1999) indicated that burns are not being administered as thoroughly in Watson's Hammock of NKDR as is needed for prevention of pine rockland loss. As a result, much of

the pine rocklands within northern Watson's Hammock are being compromised by hardwood hammock (Salvato and Hennessey 2004). Although the current burn plan within NKDR appears favorable for some butterfly species with strong flight abilities, it is not favorable for relatively sedentary butterflies, such as Bartram's hairstreak, which rarely strays from its hostplant (Worth et al. 1996). Without an appropriate hostplant-laden corridor between the area to be burned and an area of refugia for the hairstreaks to congregate within safely during the burns, the species ultimately disappears (Salvato and Hennessey 2004). Therefore, fire and fire management continues to be a threat for Bartram's hairstreak at NKDR and surrounding lands.

In summary, despite substantial habitat losses, the threat of habitat of destruction or modification of remaining unprotected pine rocklands continues today. Sporadic populations of the butterfly and suitable habitat on unprotected pine rocklands outside of ENP and NKDR largely remain at risk to development. Habitat loss, fire suppression, and lack of fire management in the past have led to the current fragmentation of remaining habitat. The threat of destruction, modification, or curtailment of habitat due to wildfire and fire management appears to have been lessened on ENP but continues on NKDR and surrounding private lands. Additional habitat loss could result in a significant further reduction in the range of this species.

B. Overutilization for commercial, recreational, scientific, or educational purposes.
Rare butterflies and moths are highly prized by collectors, and an international trade exists in specimens for both live and decorative markets, as well as the specialist trade that supplies hobbyists, collectors, and researchers (Morris et al. 1991, Williams 1996). The specialist trade differs from both the live and decorative market in that it concentrates on rare and threatened species (U.S. Department of Justice 1993). In general, the rarer the species, the more valuable it is, and prices may exceed U.S. $2,000 for rare specimens (Morris et al. 1991). For example, during a four-year investigation, special agents of the Service's Office of Law Enforcement executed warrants and seized over 30,000 endangered and/or protected butterflies and beetles, with a total wholesale commercial market value of about $90,000 in the U.S. In another case, special agents found at least 13 species protected under the ESA, and another 130 species illegally taken from lands administered by the Department of the Interior (U.S. Department of Justice 1995).

Butterflies can be subjected to intense collection pressures, and several listings of butterflies as endangered or threatened species have been based on this threat (notably the Saint Francis' satyr (*Neonympha mitchellii francisci*), emergency-listed (59 FR 18324); callippe (*Speyeria callippe callippe*) and Behren's silverspot butterflies (*Speyeria zerene behrensii*), listed as endangered (62 FR 64306); and Blackburn's sphinx moth (*Manduca blackburni*), listed as endangered (65 FR 4770)). The Saint Francis' satyr was demonstrated to have been significantly impacted by collectors in just a three-year period.

We do not have direct evidence that collection of the Bartram's hairstreak has occurred. Historically, this species, like all hairstreaks, has been highly sought after by collectors. It is unlikely that collecting or the threat of collection of this species has ceased. Salvato (pers.

comm. 2006) has not seen specimens of the Bartram's hairstreak listed by the numerous wholesale and specialty insect dealers who offer and sell butterflies to museums, artists, and collectors. However, Salvato (pers. comm. 2006) has been contacted by numerous individuals requesting specimens of the Bartram's hairstreak or in regard to locations where these individuals may collect them in the field. Thus, there is an established interest in locations and desire for specimens by collectors, researchers, and others.

As this butterfly's rarity becomes known with candidate status, risks of collection may increase. Bartram's hairstreak occurrence largely on protected Federal lands may help protect it from overzealous collectors. In the past, when this species was more widespread on Big Pine Key and throughout southern Miami-Dade County, collecting likely exhibited little pressure on this species. At present, even limited collection from the small populations of the Bartram's hairstreak in NKDR or ENP could have deleterious effects on its reproductive and genetic viability and thus could contribute to its eventual extinction. Illegal collection could occur in ENP or NKDR without being detected since these areas are not actively patrolled. Similarly, in some areas such as Navy Wells, there is no signage indicating collection is prohibited. Consequently, the potential for unauthorized or illegal collection (eggs, larvae, pupae, or adults) exists and could go undetected, despite the protection provided on Federal or other public lands.

In summary, we have no direct / absolute evidence that collection of the Bartram's hairstreak is occurring at this time. However, the established interest in specimens and information requests regarding its location on the part of collectors, researchers, and others suggests that collection may be occurring and has the potential to occur at any time. At the present time, we do not have an adequate basis to conclude that the species is currently threatened by overutilization for commercial, recreational, scientific, or educational purposes. However, due to the fact that there are only two small populations remaining, we believe that collection has the potential to be a serious threat to the species at any time.

C. Disease or predation.

Hennessey and Habeck (1991) collected a fifth-instar larva of Bartram's hairstreak on Big Pine Key from which during pupation in 1989 a single braconid wasp was produced. This is the only known record for a parasitoid towards this species. Tracking the fate of Bartram's hairstreak pupae is extremely difficult because it pupates in the ground litter (Worth et al. 1996). Collection of other late instar Bartram's hairstreak larvae is needed to determine the influence of parasitism on its early stages (Salvato and Hennessey 2004).

Crab spiders (Aranea: Thomisidae) are frequently observed during surveys for Bartram's hairstreaks on pineland croton and are likely a major predator of adult and larval (Salvato and Hennessey 2004, M. Salvato, pers. comm. 2006). Salvato (pers. comm. 2006) has observed dragonflies (Odonata) taking adult Bartram's hairstreaks within Long Pine Key. Various birds and lizards are also likely natural predators. However, at this time, it is not known to what extent disease or predation is a threat to the Bartram's hairstreak. Based on the available information, we do not consider the species to be threatened by disease or predation at this time.

D. The inadequacy of existing regulatory mechanisms.

Federal, State, and local laws have not been sufficient to prevent past and ongoing impacts to Bartram's hairstreak habitat within the species' historic range. The Bartram's hairstreak has a rounded global status of T1, critically imperiled because of extreme rarity (i.e., 5 or fewer occurrences of less than 1,000 individuals) or because of extreme vulnerability to extinction due to natural or manmade factors (NatureServe 2006). The basis for this ranking stems from the overall threats of range being reduced by development, mosquito spraying, prescribed fire, complete fire suppression, and hurricanes (NatureServe 2006). The Bartram's hairstreak is also considered Threatened by the Florida Committee on Rare and Endangered Plants and Animals (Deyrup and Franz 1994). However, these designations provide no legal authority or protection.

For scientific research on and/or collection of the Bartram's hairstreak at ENP and/or NKDR, a permit is required from the NPS or the Service, respectively. Although the Bartram's hairstreak occurs on Federal land which offers protection, these areas are vast and open to the public. Public lands can be heavily used, with signage prohibiting collection often lacking and patrolling / monitoring of activities largely absent. Therefore, potential illegal collection could occur without being detected. Since the Bartram's hairstreak is not listed by the State, it is not protected from being killed and from unauthorized take if encountered outside of NKDR or ENP. Consequently, the potential for unauthorized or illegal collection of Bartram's hairstreak (eggs, larvae, pupae, or adults) exists, as discussed under Factor B above, and could go undetected, despite its occurrence on Federal lands.

The 1979 Master Plan is the plan of record for ENP, however the NPS is currently preparing a new General Management Plan for ENP, which is still two to three years from completion (F. Herling, NPS, pers. comm. 2006). At this time, no management alternatives have been selected, but there will likely be emphasis on managing sensitive natural communities of ENP, including pine rocklands (T. Dean, Service, pers. comm. 2006). The current strategic plan for ENP indicates one NPS mission goal as "Natural and cultural resources and associated values are protected, restored and maintained in good condition and managed within their broader ecosystem and cultural context." However, since the new Plan is still in preparation, there is no way of knowing how it will affect Bartram's hairstreak, nor is there is certainty that ENP will have adequate resources to fully implement the plan once it is adopted.

Similarly, the Comprehensive Conservation Plan is the principal guiding document for National Wildlife Refuges, and the Service is in the process of developing one for NKDR. Although still in the development phase, this plan will likely focus on management of natural communities, Service trust resources, and threatened and endangered species. It is unknown to what degree the plan will address the needs of other imperiled species or the extent to which NKDR will have the resources necessary to meet its management needs.

At this time, the protection currently afforded Bartram's hairstreak is limited, provides little protection to the species' occupied habitat, and includes no provisions to protect suitable but

unoccupied habitat. Current management plans for Federal lands do not specifically address the Bartram's hairstreak, and land management practices do not currently incorporate specific life history needs for this species. Given limited resources, the ability to adequately manage fire-dependent pine rocklands on Federal lands both now and in the future remain uncertain. Management for Bartram's hairstreak is particularly complicated on Big Pine Key, where fire management (see factor A, above) and mosquito control (see factor E, below) need to address the pattern of land ownership and development, with private homes and commercial uses embedded within or in close proximity to NKDR. Therefore, we conclude that the existing regulatory mechanisms are inadequate to protect Bartram's hairstreak and its habitat.

E. Other natural or manmade factors affecting its continued existence.

As the amount of human activity and size of the human population has increased in south Florida, so has the control of salt marsh mosquitoes (*Aedes sollicitans* (Walker) and *A. taeniorhynchus* (Wiedemann)). To suppress mosquitoes, second-generation organophosphates (naled, malathion) and pyrethroid (permethrin) adulticides are used year-round throughout south Florida and from May to November in the Keys by mosquito control districts (Hennessey et al. 1992, Salvato 1999). The use of pesticides, applied using both aerial and ground-based methods, to control mosquitoes presents collateral effects on non-target species.

The lethal effect of second-generation organophosphate pesticides, such as naled and fenthion, on non-target Lepidoptera was particularly well noted initially in south Florida and the Keys, with the demise of the endangered Schaus' swallowtail butterfly (*Papilio aristodemus ponceanus*) (Emmel and Tucker1991, Eliazar 1992). This species' dramatic decline in the early 1970s coincided with the expanded use of chemical pesticides by the Monroe County Mosquito Control District (MCMCD), now known as the Florida Keys Mosquito Control District (FKMCD) on the northern Keys (Emmel and Tucker 1991, Eliazar 1992). When spraying was halted during two periods (1987 and 1989-1992), the species began to recover. The swallowtail's immediate decline when applications resumed clearly suggested the adverse effect chemical pesticides have on non-target species. Studies conducted by Hennessey et al. (1992) illustrated the presence of spray residue long after application in the habitat of the Schaus' swallowtail and several other imperiled butterflies. Baggett (1982) suggested that the rapid decline in several populations of butterflies in the Keys was directly attributable to mosquito control insecticide applications.

As of 1989, the following areas in the Florida Keys were designated no-spray zones by agreement between the Service and MCMCD: in the Upper Keys, a strip of land east of Crocodile Lake National Wildlife Refuge (NWR), Elliott Key, and several of the smaller keys of Biscayne National Park; and in the Lower Keys, the small outlying areas of the NKDR.

Still, essentially all of the pine rocklands within NKDR except Watson's Hammock on Big Pine Key are sprayed with naled (aerially applied adulticide); additionally, residential areas and roadsides across Big Pine Key are treated with permethrin (ground-based applied adulticide) (Salvato 1999). In short, basically all areas of Big Pine Key, except Watson's

Hammock and Cactus Hammock, are sprayed with naled or permethrin. Therefore, Bartram's hairstreak and its occupied and suitable habitat on Big Pine Key are directly exposed to adulticides used for mosquito control.

Designation of no-spray zones does not mean a lack of chemical intrusion. These areas were established with the understanding that there was to be no use of insecticides, and any residues detected within would be unacceptable. When these zones were created, pesticide drift downwind into them had not been documented. However, Hennessey et al. (1992) detected naled residues 750 m (2,460 feet) into the no-spray zone at Watson's Hammock, 150 m (492 feet) at Cactus Hammock, and 30 m (98 feet) into the Schaus' swallowtail habitat on Crocodile Lake NWR. Truck-applied ultra-low-volume (ULV) fenthion, sprayed primarily in residential areas, did not appear to drift into non-target areas. This study indicated that naled remained in the habitat well into midday, posing risk to diurnally active non-target species, such as Bartram's hairstreak. Therefore, in addition to being directly applied to occupied and / or suitable habitat throughout Big Pine Key, Bartram's hairstreaks utilizing Watson's Hammock are also exposed to chemical residues 750 m (2,460 feet) within its borders, despite the protection provided by being within a no-spray zone.

Eliazar (1992) conducted intensive testing on the effects of the chemical pesticides naled and fenthion on several south Florida butterfly species. His results indicated that chemical pesticide and their field application rates, particularly those of naled, were extremely toxic to non-target Lepidoptera, and were being administered in the field at levels above the dosage required to kill target *Aedes* mosquitoes. Eliazar's naled experiments, conducted in the laboratory, included several butterfly species (not Bartram's hairstreak) likely to be found in the Lower Keys. However, his results suggest that naled or fenthion used at the field application rates would have lethal or at least sublethal effects on Bartram's hairstreak when applied in occupied or suitable habitat.

Salvato (1999, 2001) also measured the toxicity of naled as well as permethrin on a number of surrogate species, and these adulticides were highly toxic towards these butterflies in both immature and adult stages. Furthermore, Salvato (1999, 2001, pers. comm. 2006) has been monitoring populations of Bartram's hairstreak on survey transects on Big Pine Key within NKDR since 1997 and has indicated that numbers of hairstreaks encountered across the island is likely only a fraction of what might occur were adulticide applications restricted or limited within NKDR lands. According to Salvato, the species' tendency to congregate in large densities on flowers of the hostplant along pine rockland clearings and roadsides on Big Pine Key makes the Bartram's hairstreak far more susceptible than other butterflies to both aerial and truck applied adulticide applications (Salvato 1999, 2001; M. Salvato, pers. comm. 2006).

During his ongoing survey, Salvato (1999, 2001, pers. comm. 2006) has not found significantly larger densities of Bartram's hairstreak within the unsprayed Watson's Hammock area of NKDR, as he has for other butterfly species. Salvato attributes this to a lack of adequate fire management in this part of NKDR. Salvato believes that fragmentation of host plant within Watson's Hammock has resulted in reduced numbers of Bartram's

hairstreak in this area compared to elsewhere on Big Pine Key where the hostplant grows more continuously (M. Salvato, pers. comm. 2006).

Spraying practices by the FKMCD at NKDR have changed recently to reduce pesticide use. According to the Special Use Permit issued by the Service, the number of aerially applied naled treatments allowed on NKDR has been reduced to a specified allotment (i.e., 9 per mosquito season, no closer than 5 days apart (R. Frakes, Service, pers. comm. 2006)). These changes were made after the Service reviewed the toxicity of naled on federally listed species that occur within NKDR; however, this analysis did not include species of Lepidoptera, since none on NKDR are listed. Since insects are more sensitive to organophosphates than the vertebrate species considered in the analysis, negative impacts to Bartram's hairstreak and other Lepidoptera from continued naled applications will likely occur, despite the reduced use of this insecticide.

Historically on Big Pine Key, only Watson's Hammock and eastern Cactus Hammock have been restricted from mosquito control spraying. However, the remainder of Big Pine Key, including the entire NKDR, remains open to adulticide applications. Allowing treatments to pine rockland habitats, even on a reduced basis will continue to negatively affect butterflies and other non-target arthropods on NKDR. Although Bartram's hairstreak may maintain numerous broods throughout the year on Big Pine Key, their densities, even under the best historical conditions, apparently were not prolific enough to survive and adapt to the mosquito control treatments currently occurring in pine rockland habitat. Bartram's hairstreak generally has 6 to 10 generations per year of normally only a few hundred individuals, whereas pest species have much more frequent broods throughout the year and in much higher densities (e.g., for mosquitoes in the millions of individuals). A reduced number of aerial naled applications, such as nine treatments per mosquito season, will likely continue to negatively affect the Bartram's hairstreak. Given the toxicity of naled towards non-target species, frequent exposure of these adulticides cannot be discounted as anything less than a major threat to the Bartram's hairstreak across Big Pine Key.

In general Long Pine Key is not impacted by mosquito control practices, except for the use of adulticides in residential areas and campgrounds. However, other sporadic Bartram's hairstreak populations adjacent to and outside ENP and other suitable and potential habitat within Miami-Dade County are vulnerable to the lethal and sublethal effects of adulticide applications.

Butterflies in south Florida and the Keys, such as Bartram's hairstreak, have adapted over time to the influence of tropical storms and other forms of adverse weather conditions (M. Salvato, pers. comm. 2006). However, given the substantial reduction in the Bartram's hairstreak's historic range in the past 50 years, the threat and impact of tropical storms and hurricanes on the remaining populations of this species is much greater than when its distribution was more widespread. The active hurricane season of 2005 resulted in extensive damages to pine rockland habitats both within the NKDR and ENP. Although there was substantial damage to the Bartram's hairstreak hostplant in both the Watson's Hammock area

of NKDR and Gate 4 (trail) area of Long Pine Key following storm activity, both areas appear to be recovering (M. Salvato, pers. comm. 2006). The possibility of future hurricanes striking the Atlantic or Gulf Coast of Florida is likely. According to the National Oceanographic and Atmospheric Administration, Miami-Dade County, the Keys, and western Cuba are the most storm-prone areas in the Caribbean so this threat is expected to continue.

The Bartram's hairstreak is highly vulnerable to extinction due to its extremely small number of remaining populations that are small and isolated. In general, extreme isolation, whether caused by geographic distance, ecological factors, or reproductive strategy, will likely prevent the influx of new genetic material and can result in a highly inbred population with low viability and/or fecundity (Chesser 1983). Natural fluctuations in rainfall, hostplant vigor, or predation may weaken a population to such an extent that recovery to a viable level would be impossible. Isolation of habitat can prevent recolonization from other sites and result in extinction. Although we do not have evidence that this is the case for Bartram's hairstreak, fragmentation of habitat and the limited dispersal capabilities of this butterfly lead us to believe this species is especially vulnerable due to the small number of populations remaining, their small size, and their relative isolation.

The small population size within extremely localized areas may make Bartram's hairstreak vulnerable to extinction due to genetic drift, inbreeding depression, extreme weather events (e.g., hurricanes) and random or chance changes to the environment (Lande 1988, Smith 1990, Saccheri et al. 1998) that can significantly impact its habitat. Inbreeding depression can result in death, decreased fertility, smaller body size, loss of vigor, reduced fitness, and various chromosome abnormalities (Lande 1988, Smith 1990). Saccheri et al. (1998), studying the effect of inbreeding on local extinction, found extinction risk of the Glanville fritillary (*Melitaea cinxia*) increased significantly with decreasing heterozygosity.

Despite a species' evolutionary adaptations for rarity, habitat loss and degradation increase a species' vulnerability to extinction (Noss and Cooperrider 1994). Several authors (e.g., Pimm et al. 1988, Noss and Cooperrider 1994, Thomas 1994, Kale 1996) have indicated that the probability of extinction increases with decreasing habitat availability. Although changes in the environment may cause populations to fluctuate naturally, small and low-density populations are more likely to fluctuate below a minimum viable population (i.e., the minimum or threshold number of individuals needed in a population to persist in a viable state for a given interval) (Shaffer 1981, Shaffer and Samson 1985, Gilpin and Soule 1986). Current threats to the habitat of Bartram's hairstreak may exacerbate potential problems associated with its low population numbers and increase the chance of this species becoming extinct.

In a review of 27 recovery plans for listed insect species, Schultz and Hammond (2003) found that 25 plans broadly specified metapopulation features in terms of requiring that recovery include multiple population areas (the average number of sites required was 8.2). The six plans quantifying minimum population sizes as part of their recovery criteria ranged from 200 butterflies per site (Oregon silverspot (*Speyeria zerene hippolyta*)) to 100,000

adults (Bay checkerspot (*Euphydryas editha bayensis*)). Although highly dependent upon species, a population of 1,000 has been suggested as marginally viable for an insect (D. Schweitzer, The Nature Conservancy, pers. comm. 2003). Schweitzer (pers. comm. 2003) has also suggested that butterfly populations of less than 200 adults per generation would have difficulty surviving over the long-term. Therefore, the Bartram's hairstreak population at Big Pine Key (i.e., estimated at 160 – 500) appears to be especially at risk.

Schultz and Hammond (2003) used population viability analyses to develop quantitative recovery criteria for insects whose population sizes can be estimated and applied this framework in the context of the Fender's blue (*Icaricia icarioides fenderi*), a butterfly listed as endangered in 2000 due to its small population size and limited remaining habitat. They found the Fender's blue to be at high risk of extinction at most of its sites throughout its range despite that fact that the average population at 12 sites examined ranged from 5 to 738. Of the three sites with populations greater than a few hundred butterflies, only one of these had a reasonably high probability of surviving the next 100 years (Schultz and Hammond 2003). Although the conservation needs and biology of the Bartram's hairstreak and Fender's blue are undoubtedly different, most remaining habitat for each species is completely isolated.

The Bartram's hairstreak is largely restricted to two locations, one occurring within pine rocklands of Big Pine Key, a second within Long Pine Key. Distance between these populations and the small size of highly sporadic populations make recolonization unlikely if populations are extirpated.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

Although not specifically conducted for this species, fire management practices of pine rocklands within ENP and potentially NKDR may provide benefits for the Bartram's hairstreak. The *Florida Comprehensive Wildlife Conservation Strategy* discusses management of pine rocklands, but has not been implemented or funded.

SUMMARY OF THREATS

At its only known locations, the Bartram's hairstreak and its habitat are vulnerable to a wide variety of natural and human factors. The small, isolated populations are exposed to extreme weather events (e.g., hurricanes). Mosquito control practices are a major threat to the population on Big Pine Key, including the NKDR, which is one of only two remaining. Habitat of the Bartram's hairstreak, pine rocklands, is globally imperiled, and dependent upon fire. Inappropriate fire management or wildfire could destroy the Bartram's hairstreak and impact the availability of pineland croton, its sole host plant. Further reduction of the populations, especially due to catastrophic weather, mosquito spraying, loss of remaining unprotected suitable habitat, or inappropriate fire management, could severely reduce the likelihood of this butterfly's survival. Finally, the established interest in specimens of Bartram's hairstreak and information requests regarding its location on the part of collectors, researchers, and others suggests that collection may be occurring and has the potential to occur at any time. At the present time, however, there is insufficient information to conclude that the species is currently threatened by overutilization for commercial, recreational, scientific, or educational purposes.

RECOMMENDED CONSERVATION MEASURES

- Address concerns regarding impacts of mosquito control activities in relation to pine rockland habitats on NKDR and adjacent properties.
- Review and adjust fire management practices as needed to help maintain or expand the population size or numbers of populations.
- Protect remnant patches of pine rocklands and use of prescribed fire to restore native plant diversity.
- Restore pineland croton to relict fragments of pine rocklands within the species' historic range to expand its occupied habitat.

LISTING PRIORITY

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	**Imminent**	Monotypic genus	1
		Species	2
		Subspecies/population	**3***
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude: The Bartram's hairstreak is threatened by the combined influences of habitat destruction and modification from continued loss of unprotected pine rocklands and wildfire or fire management on protected sites. Mosquito control activities are a serious threat to the butterfly at NKDR, one of its two remaining populations, as well as anywhere the species occurs outside of ENP. Loss of genetic diversity may be a problem for the butterfly considering its small, fragmented, and isolated populations. The probability for catastrophic events (e.g., hurricanes) and the possibility of accidental harm or habitat destruction are considered threats to the survival of this butterfly, due to the small population sizes at few remaining locations. In addition to these threats, displacement of native hostplants by invasive exotic species and inadequate regulatory protection continue to pose threats to the species throughout its historic

range. Overall, we find that these threats are of high magnitude. We also recognize that illegal collection is a potential threat to the species.

Imminence: The threats of habitat destruction and modification are occurring with the continued loss of unprotected pine rocklands and wildfire or fire management on protected sites. The Bartram's hairstreak continues to be negatively impacted by adulticides used for mosquito control on Big Pine Key and outside of ENP. The threat from loss of genetic diversity within small, fragmented, and isolated populations is expected to continue. The likelihood of extreme weather or catastrophic events (e.g., hurricanes) to both of the remaining populations also seriously threatens the survival of this butterfly, and these threats are expected to continue. We find the above threats to be currently occurring and imminent. In addition, since there is an established interest in locations and desire for specimens by collectors, researchers, and others, we believe this species is at risk of collection and that this may be occurring and has the potential to occur unnoticed at any time, since areas are remote and open to the public.

Rationale for Change in Listing Priority Number (insert if appropriate)

Yes Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted? No. At this time, emergency listing is not warranted because there are two populations of the Bartram's hairstreak on Federal lands, with the population ranging from an estimated 160 to 800 adults. Since this butterfly is being regularly monitored, the Service should be aware of any further reduction in the number of populations, changes in size of its population, and degradation of habitat in a timely manner to undertake emergency listing, should it be necessary.

DESCRIPTION OF MONITORING

Surveys for the Bartram's hairstreak butterfly are ongoing. Salvato (1999, 2001, pers. comm. 2006; Salvato and Hennessey 2004) continues monitoring for this species that began in 1997 and has been conducted either monthly or bi-monthly throughout the historic range of the Bartram's hairstreak in south Florida and Lower Keys. The Service is working with Salvato, in the form of providing annual Special Use Permits for mark-release studies in NKDR, to monitor the species. Similar cooperation is given to Salvato by the NPS for monitoring the species within ENP.

COORDINATION WITH STATES

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: None.

Indicate which State(s) did not provide any information or comments: Florida. A previous version of this form, dated October 13, 2005, was sent to the Florida Fish and Wildlife Conservation Commission, the NPS, and the NKDR; however, no comments or additional information have been received to date.

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APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: /s/ Jeffrey M. Fleming 8/4/2006
Acting Regional Director, Fish and Wildlife Service Date

Concur: August 23, 2006
Director, Fish and Wildlife Service Date

Do not concur:
Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: October 13, 2005; updated August 4, 2006
Conducted by: Paula Halupa, South Florida Ecological Services Office

(Revised 8/4/06)